Method in reeling up and a reel-up

The invention relates to a method in reeling up, which is of the type presented in the preamble of the appended claim 1. The invention also relates to a reel-up, which is of the type presented in the preamble of the appended claim 10.

In the final end of a paper machine or a finishing apparatus for paper, a typically several meters wide paper web, which has been produced and/or treated in earlier machine sections, is reeled around a reel spool to form a machine reel. In this reeling up process a reeling cylinder that is journalled rotatable is typically used for guiding the paper web on the machine reel, wherein the nip contact between the reeling cylinder and the machine reel is utilized to influence the quality of the reel produced thereby. A conventional solution is the one in which the reeling cylinder remains stationary and the reel spool around which the reel is accumulated in nip contact is moved during reeling up in the supporting structure, for example by supporting the ends of the reel spool on reeling rails. The ends of the reel spool are affected with a suitable loading mechanism to adjust the nip contact between the machine reel that is being formed and the reeling cylinder. Such reeling concepts and loading methods related thereto are disclosed, for example, in the Finnish patent 91383 and in the corresponding US patent 5,251,835, as well as in the Finnish patent application 950274 and in the corresponding US patent 5,690,298.

Another known solution is the one in which the reeling cylinder is arranged to move on a carriage, and the machine reel is rotated with center drive in a stationary reeling station, i.e. the center of the reel spool remains in the same location. When the radius of the machine reel increases, the reeling cylinder shifts in such a manner that the carriage supporting the same moves in the guide. Such an arrangement is known, for example, from the European application publication 792829 and in the corresponding US patent 5,988,557.

The US patent 5,370,327 discloses a solution in which the reeling cylinder moves in the vertical direction, thus making it possible to

maintain the angular position of the nip between the reeling cylinder and the machine reel constant when the reel moves on the reeling rails. The low position of the reeling cylinder and the movement of the same in the vertical direction enable the transfer of the reel spools from a storage to a reeling station along a straight transfer path. The solution contains two pairs of reeling carriages, of which the pair that has delivered a full machine reel can return past the other pair that is guiding the reel to be reeled, to retrieve a new empty reel spool.

In addition to the stationary reeling cylinder that guides the web on the reel, according to the Finnish patent application 950274 and the corresponding US patent 5,690,298 it is possible to use an auxiliary roll located at a lower position and moving in the vertical direction, said auxiliary roll forming a second nip with the machine reel formed in the moving reeling station. Before the change this auxiliary roll is in contact with the reel that is becoming full, which has been run off the reeling cylinder. A corresponding arrangement in connection with a change is disclosed in the Finnish patent 91383/ US patent 5,251,835.

In addition, from publication EP-860391 is known a reel-up, in which the web is guided on a reel via a belt or a wire, which is led via guide rolls. Thus, by means of the belt or the wire, a long reeling nip having an even pressure is provided on the area of the lower half of the reel. The pressure can be adjusted through the tension of the belt or the wire. The belt or wire loop can be tilted in the vertical plane in such a manner that the first guide roll in the travel direction of the web can be lifted against the new reel spool, which rests on the reeling rails above the belt. When growing, the reel moves forward on the reeling rails in such a manner that it is continuously in contact with the downwards-tilted run of the wire or belt, which follows the guide roll and via which the web comes on the reel.

In addition, from the patent US-5531396 is known a reel-up, in which the wire loop is guided over the reeling cylinder in such a manner that it guides the web after the reeling cylinder on the reel being formed.

The problem with the reel-ups using a wire or a belt is the change from reeling by a hard nip (by means of a guide roll) over to wire or belt reeling when forming the bottom of the reel in primary reeling. This requires possibilities for movement from the primary reeling device, both in the vertical and horizontal direction.

The purpose of the invention is to provide a new reeling up method using a belt and a wire, by means of which the reeling up of a bottom can be better implemented, simultaneously preserving the advantages of known methods. To attain this purpose, the method according to the invention is primarily characterized in what will be presented in the characterizing part of the appended claim 1. The first guide roll is transferred in the peripheral direction of the reel spool against the incoming direction of the web. Thus, it is possible to implement the reeling up of the bottom first with a hard nip and after the transfer with a softer nip. Thus, the reel spool does not need to be transferred during primary reeling. The reel-up according to the invention, in turn, is characterized in what will be presented in the characterizing part of the appended claim 10.

As for the other embodiments of the invention and the advantages of the same, reference is made to the appended dependent claims and to the description hereinbelow.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 illustrates schematically the main principle of the reel-up in a side view,

Figs. 2 to 6 illustrate the different stages of the reeling up process in a side view of the reel-up, and

Figs. 7 to 11 illustrate the different stages of the reeling up process in a side view of the reel-up according to a second embodiment.

Fig. 1 illustrates a continuously operating reel-up, where the paper web W coming from a preceding section of a paper machine or a finishing apparatus for paper, which web is normally several metres wide, travels via the reeling nip N onto the reel R. The reeling nip is formed by means of a flexible supporting member 1 in the form of an endless loop, such as a belt or a wire. The supporting member 1 is guided over two guide rolls 2 and 3, at each of which the run of the member 1 turns to the opposite direction. In the travel direction of the web the first guide roll 2 can form a "hard nip" with the reel being started in the initial stage of reeling up in such a manner that the supporting member 1 is in contact with the reel at a point where the member travels supported by the guide roll 2 on the surface of the roll. The latter guide roll 3 or the first guide roll 2 can be a driven roll, i.e. a traction roll, or separate drives can be arranged for both rolls. The web travels guided by the supporting member 1 onto the machine reel R, which is formed around a reel spool 5 rotatable with its own center drive. It is possible for the reel spool 5 to move in the machine direction with respect to the loop of the supporting member 1, and this is arranged in such a manner that the bearing housings at the ends of the reel spool that enable the rotation of the reel spool 2 are supported with suitable supporting structures. In connection with the reel-up, there is also a storage of empty reel spools 5 (not shown), from where the rolls are brought to the change station at the first guide roll 2 in order to change the web going to the machine reel R that is becoming full. The reel change takes place at production speed i.e. the paper web passed at high speed to the full reel is changed to travel onto a new reel spool brought to the change station.

The machine reel R can be transferred in the machine direction in a transfer device 7, which supports the bearing housings at the ends of the reel spool and which is moved by means of actuators attached to the frame of the reel-up. The transfer device 7 is arranged to move on substantially horizontal reeling rails 6 extending in the machine direction, and it is formed of a carriage at each end of the reel spool, which supports the bearing housing at the end of the reel spool 5. When the diameter of the machine reel R increases, and the reel moves forward, it is in continuous contact with the supporting member

1 because the transfer path of the transfer device 7 and the web-carrying portion of the supporting member 1 together form an angle opening in the transfer direction. In Fig. 1, the upper, web-carrying portion of the loop of the supporting member 1 is directed diagonally downwards in its direction of movement, whereas the transfer path of the reel R (and the reel spool 5) is substantially horizontal.

Fig. 2 illustrates a situation in the primary stage of reeling up in a situation where the reel spool 5 and the reel R formed around it during primary reeling is transferred from the primary reeling device 8 to the transfer device 7, which operates as a secondary reeling device. For this, the transfer device 7 is run in the direction pointed out by the arrow against the travel direction of the web to a point close to the primary reeling device 8. In this stage the web W travels to the reel R via the portion of the supporting member 1 coming after the first guide roll 2.

Fig. 3 illustrates a situation where the transfer device 7 is transferred along the reeling rails 6 forward in the travel direction of the web according to the increase in the diameter of the reel R so that the reel is, at its lower side, always in contact with the loop of the supporting member 1 in such a manner that the web moves over to the outer periphery of the reel R in the reeling nip N between the web-carrying portion of the loop and said outer periphery. The reel spool 5 forming the core of the new reel is brought to the primary reeling device 8. Fig. 3 also illustrates a situation, where the loop of the supporting member 1 has been transferred forward in the machine direction in such a manner that the first guide roll 2 is located directly below the new reel spool 5. The movements of the first guide roll 2 and the loop are described more in detail hereinbelow.

Fig. 4 illustrates a situation, where the new reel spool 2, by vertically lowering the primary reeling device 8, has been brought to the change station in contact with that portion of the loop of the supporting member 1 that travels on the first guide roll 2 in order to create a so-called hard nip. Before this the new reel spool 5 has been accelerated to the web speed with the drive of the primary reeling device 8. In the change

station the plane connecting the central axis of the reel spool 5 and the central axis of the guide roll 2 is substantially vertical. In comparison to the situation of Fig. 3, the old machine reel R in the secondary reeling has moved forward according to the increase in the reel diameter, i.e. the reeling nip N between the reel R and the loop of the supporting member has moved to the travel direction of the upper portion of the loop. The paper web W now travels between the new empty reel spool 5 and the first guide roll 2 of the loop, and further along the upper web-carrying portion of the loop of the supporting member 1 and moves over to the periphery of the old reel R in the reeling nip N. Fig. 4 further illustrates how in this stage the old reel R has come into contact with a press roll 9 that is journalled rotatable and rotated with a drive of its own, the purpose of which is the ensure the density of the surface layers of the reel. The nip through which the web travels between the supporting member 1 and the shell of the new reel spool 5 is marked with the reference N1.

Fig. 5 illustrates a situation where the web going to the old reel R has been changed to travel around the new reel spool 5, i.e. after the nip N1 between the reel spool 5 and the first guide roll 2, the web follows the surface of the new reel spool 5 and begins to form a new machine reel R around it, in which case the above-mentioned nip N1 forms a reeling nip in the primary reeling. The change methods that are not described more in detail here may comprise suitable blowings of air, by means of which the web is brought to tear and to be guided around the new reel spool 5. The change is performed in a know manner at full web speed, i.e. at the production speed of the web. The reel spool 5 is in the primary reeling device 8 during the change.

Fig. 5 presents how the end point of the secondary reeling of the old reel R is before the second guide roll 3 (the location of the nip N). It is also possible to continue the secondary reeling in such a manner that the reeling nip N moves all the way to the end of the downwardly diagonal portion of the loop of the supporting member 1 over the second guide roll 3.

Fig. 6 illustrates a situation where the old full machine reel R has been transferred with the transfer device 7 forward to the removal station away from the contact with the loop of the supporting member 1 while the press roll 9 moves according to the transfer movement in such a manner that it is in continuous contact with the surface of the machine reel R. When the old machine reel R has been transferred off the loop of the supporting member and when a layer of a certain thickness has been gathered around the new reel spool 5 in the first primary reeling stage, the loop of the supporting member 1 is transferred in a manner pointed out by the arrow in the peripheral direction of the reel spool against the incoming direction of the web in such a manner that the first guide roll 2 moves further away from the new reel, and the peripheral surface of the reel comes against the loop in the free portion of the supporting member 1 following immediately the guide roll 2, i.e. the situation is the same as in Fig. 2. The new reel spool is in this stage still in the primary reeling device 8. The reeling nip N1 therefore moves in relation to the guide roll 2 in the travel direction of the supporting member 1.

The incoming direction of the web here refers to the direction in which it enters the reeling nip between the loop of the supporting member 1 and the reel spool 5. The web W can thus either come guided by the first guide roll 2 on that portion of the loop of the supporting member that curves over the guide roll 2 (in the manner presented in Figs. 4 to 6, where entry of the web to the loop is guided by a web guide roll 10 before the loop), or it can also come to the nip guided by the reel spool 5 and the web layers on top of it, i.e. it is first guided along the surface of the reel before entering the reeling nip N1.

When the full reel R has been removed from the reel-up, the transfer device 7 is free to move on the rails 6 towards the primary reeling device 8 into the position of Fig. 2, where the reel spool 5 in the primary reeling device 8 and the reel R that has started to form around it are delivered to the transfer device 7 for secondary reeling. The secondary reeling of this new reel R then proceeds again along the upper web-carrying portion of the loop of the supporting member 1 according to Figs. 2 to 6. During secondary reeling the guide roll 2 is

transferred again back in the travel direction of the web (from the position of Fig. 2 to the position of Fig. 3), i.e. to a location where it will be when a new reel spool is brought to the change station again.

It is to be noted that the nip contact with the supporting member 1 is continuous during the entire reeling up, i.e. when changing from primary reeling to secondary reeling the nip contact to the loop of the supporting member is continuously maintained when the reel spool 5 is delivered from the primary reeling device 8 to the transfer device 7. The transfer device 7 can start to convey the reel spool 5 and the reel directly forward from that fixed position where the primary reeling device 8 has kept the reel spool 5 at the change moment and during the entire primary reeling. When the reel spool 5 is delivered from the primary reeling device 8 to the transfer device 7, the torque rotating the reel spool 5 can be changed from the drive of the primary reeling device 8 to the drive of the transfer device 7 in previously known manners. The drive of the transfer device 7 moves along with the transfer device and rotates the reel spool 5 and the reel R around it during the secondary reeling at a speed required by the production speed, until the full reel starts to decelerate after the web cutting.

Transferring the first guide roll 2 against the incoming direction of the web W achieves the advantageous effect that the location where the loop of the supporting member 1, such as a belt or a wire, is against the periphery of the new reel that has started to form around the reel spool 5 is shifted from the guide roll 2 to the free portion of the supporting member 1 following after it. The same relative shift could, in fact, be achieved by transferring the reel spool 5 in the primary reeling device forward in the conveying direction of the belt loop. However, a drawback in this case is that in the primary reeling it would be necessary to guide the movement of such a reel spool 5 whose mass changes continuously because of the web W gathered around it. When operating with the method according to the invention, the central axis of the reel spool 5 can be kept in fixed position in this transfer stage of the reeling nip and even during the entire primary reeling. This, in turn, makes it possible to form the primary reeling device 8 stationary at least in such a manner that it can be moved only according to one

transfer path that is substantially vertical, but it is not necessary to arrange a possibility for horizontal movement for it in order to transfer the reel spool 5 in the direction of the supporting member loop.

There are also other advantages in the movement possibility of the guide roll 2 in the peripheral direction of the reel spool 5. When the position of the guide roll 2 can be changed in the manner described hereinabove, it is firstly possible to select whether the reeling up of the bottom around a new reel spool 5 is started directly against the hard reeling nip N1 (against the supporting member 1 travelling over the first guide roll 2), or directly solely against the supporting member 1 (the free portion of the supporting member following after the belt guide roll 2), i.e. against the "soft" reeling nip N1. In order to select this starting position it is not necessary to transfer the reel spool 5, but it can be lowered to the change station with the primary reeling device 8 always along the same transfer path, and the starting position only depends on the position to which the first guide roll 2 has been driven. When the web has been changed to travel on the reel spool 5 in the change station, the reeling of the bottom is started immediately against either the hard nip or the soft nip.

Advantageously the procedure is such that after the change, in the first primary reeling stage, the bottom of the reel, i.e. the first web layers, around the reel spool 5 start to be reeled against the hard nip N1 while the reel spool 5 remains in the change station, and after this a second primary reeling stage is entered by transferring the first guide roll 2 in relation to the reel spool 5, after which the bottom is reeled against the soft nip N1.

By transferring the guide roll 2 in the machine direction, a suitable starting point is found, where the guide roll is located during the change and the first primary reeling stage. When the web has been changed and the reel begins to increase around the new reel spool, the guide roll 2 is moved in the vertical direction downwards according to the increase of the reel, and by means of this movement, also the linear load of the reeling nip in the first primary reeling stage is adjusted.

Fig. 1 illustrates schematically the movement possibilities of the first guide roll 2 and the second guide roll 3. The first guide roll 2, by means of which the location of the reeling nip can be determined in the primary reeling, is advantageously movable both in the vertical direction and in the horizontal direction in directions perpendicular to its axis of rotation in such a manner that the transfer movements in these directions are independent of each other. Thus, the guide roll 2 can be located in an accurately selected point in a vertical plane coinciding with the travel direction of the web within an area of certain size, and the transfer from the first point to a second can be implemented over a desired transfer path. The same possibility for movement exists also with the second guide roll 3. In practice, the movement in the case of both guide rolls can be implemented by attaching the roll rotatably to a first element and movably in it linearly in one direction in the above-mentioned vertical plane, and arranging in turn said element movably linearly in a direction perpendicular to this first direction in the same vertical plane. An element of this kind is at both ends of the roll on the edge of the reel-up.

In an embodiment according to Figs. 2 to 7, the entire loop 1 of the supporting member 1 must move according to the movement of the first guide roll 2, i.e. the second guide roll 3 must follow the movement of the first guide roll 2 in such a manner that the desired position of the loop is kept. This can be implemented in such a manner that the axes of rotation of the first guide roll 2 and the second guide roll 3 are interconnected with a rigid connecting body, which is schematically illustrated by the dotted line in Fig. 1. In practice, the movements can further be implemented in such a manner that each guide roll is mounted movably in the height direction in the carriage of its own, which in turn can be transferred in the machine direction in the frame of the reel-up. Thus, for example, by actively moving the carriage of the first guide roll 2 and by actively adjusting the height position of the guide roll 2 in the carriage, the guide roll can always be placed in the correct position in relation to the primary reeling device 8 and the reel spool in it 5. The second guide roll 3 follows the movement of the first guide roll in such a manner that the angle of the loop of the supporting member in relation to the horizontal plane changes in a desired manner

or remains constant. In practice, the movement of the second guide roll 3 must be actively guided only in one direction, and the roll will automatically position itself in a direction perpendicular to said direction due to the rigid connecting body. For example, when transferring the carriages of the first guide roll 2 with active actuators and when adjusting the height position of the roll 2 in the carriages with the active actuators of these carriages, only height has to be actively adjusted in the carriage of the second roll 3, and the carriages follow the movement of the first roll 2 automatically in the machine direction via the rigid connecting body.

The tension of the supporting member 1, which is one of the manipulated variables during primary reeling and especially during secondary reeling, can be implemented, for example, with a tension roll attached in a movable manner to the connecting body of the rolls and in contact with the loop of the supporting member 1.

A second possibility to arrange the movement of the loop of the supporting member is to arrange the guide rolls 2 and 3 movably in such a manner that they are not connected together via a rigid connecting body which would determine the distance between their center-points, but they are movable completely independently of each other, within the limits set by the loop. The possibilities of movement for both rolls can be the same as above, e.g. they can be moved both in the height direction and the machine direction, but by means of their mutual movement it is now possible to adjust the tension of the supporting member 1 as well.

As can be seen from the figures, the primary reeling device can be moved in a vertical direction along the vertical guides in the frame of the reel-up, i.e. the movement is linear. The locking jaws of the primary reeling device, to which the bearing housings of the new reel spool 5 can be attached are directed from this frame to that direction where the reel is to be transferred during secondary reeling, i.e. the transfer direction of the transfer device 7. The nip N1 between the new reel spool 5 and the supporting member 1 can be closed by lowering the primary reeling device and by keeping the first guide roll 2 and the loop

of the supporting member in that position where it has been transferred earlier, or by keeping the primary reeling device 8 at its place and by lifting the first guide roll 2 up until the web remains between the supporting member 1 and the reel spool 5.

Figs. 7 to 11 illustrate a reel-up where the stages are principally the same as the ones described hereinabove. In addition to the first guide roll 2 and the second guide roll 3, there is, however, a third roll inside the loop of the supporting member 1, an additional roll 11, which is located in the travel direction of the web before the first guide roll 2. At the first guide roll 2 the travel direction of the loop does not change to the opposite, but the diagonally upward directed portion of the supporting member 1 turns to a diagonally downward directed portion, along which the reeling nip N transfers in the secondary reeling. On the diagonally upwards directed portion between the additional roll 11 and the first guide roll 2 the supporting member 1 carries the web towards the reeling nip N1. The additional roll can be used to adjust the tension of the supporting member. In addition, a roll 12 in contact with the supporting member outside the loop is presented, which can be used as a guiding roll, which positions the supporting member 1 in the lateral direction by means of the movement in its one end (arrows).

The advantage in the embodiment of Figs. 7 to 11 is that, only the first guide roll 2 of the rolls inside the loop is to be moved when desiring to change the mutual location of the guide roll 2 and the reeling nip N1 in the primary reeling, and the other rolls can remain in the same position in all stages.

The plane-like flexible supporting member 1, which forms a closed loop by means of two or more rolls, is advantageously air permeable, for example a wire. However, also such supporting members that are air impermeable are within the scope of the invention, for example, belts having closed surface. The supporting member is of the same structure in the lateral direction of the machine, i.e. it corresponds to the width of the web being reeled. However, the scope of the invention also includes the idea that the loop is formed of several loops travelling next to each other in parallel relationship, while the general geometry in

side-view is exactly the same as in Figs. 2 to 11. Thus, the tension of the loops can, for example, be adjusted independently according to the principles known from the publication EP-860391.

The primary reeling device 8 is preferably movable vertically up and down, in which case in the upper position it fetches a new reel spool 5 from the storage and in the lower position forms a change and primary reeling station. It is, however, possible that the primary reeling device, which keeps the new reel spool during change and primary reeling stage, is completely stationary in its position. In this case, the new reel spool is brought with special transfer members, for example, a crane, from above to the primary reeling device. Thus, the reeling nip N1 must be closed by moving the first guide roll 2.